Space Weather Technical Forecast

Issued on Monday, 15 April 2024 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance G1/G2 on day 1 (15 Apr) from with CH fast wind onset and CME arrivals, and perhaps day 3 (17 Apr) with a further CME arrival. Isolated M-flares likely.

Solar Activity: Moderate with one M-class flare, peaking M4.3 at 14/0232 UTC from AR3637, a small but magnetically unstable sunspot in the southeast, with a small delta spot. There are twelve sunspot regions visible, the largest AR3634 in the northeast with some ongoing growth observed, including the development of a small reverse polarity spot near its trailer, leading to increased complexity. Growth was also observed with the trailer of AR3639 in near the northeast limb, AR3641 in the northeast, and a new spot to the northwest of this region. A new spot was also evident near the southeast limb, set amongst the broad plage that also includes AR3637 and AR3638.

A C5.0-flare from AR3636 in the southeast and subsequent nearby filament eruption resulted in a faint partial halo CME, which is still under analysis. Preliminary results suggest the potential for an Earth-directed CME arriving on day 3 (17 Apr), however confidence is low with the potential for the CME to be from an alternative, perhaps far-sided, source.

Solar Wind / Geomagnetic Activity: Solar winds as observed by ACE at L1 showed the onset of weak fast wind enhancement from CH24/-. Speeds increased from background to be slightly elevated, rising from around 330km/s to around 400km/s. Density was just below or around average. Interplanetary magnetic field (IMF) strength, Bt, remained weak below 6nT, with the north-south component, Bz, also only varying weakly, between -4nT and +5nT. Phi angle started positive (away from the Sun), but switched to a negative (towards the Sun) orientation at around 14/0630 UTC. Resultant geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at Background. High energy electron flux (greater than 2MeV) observed at GOES16 was Background to Moderate, with a peak of 484pfu observed at 14/1550UTC. The associated 24-hour fluence remained below Active (1e8 integrated flux) with a value of 1.55e7 integrated pfu recorded at 15/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is expected, with a likelihood of further isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are up to three Earth directed CMEs. The first from a filament eruption on 11 Apr was low confidence for giving a glancing impact 14 Apr, and has yet to be observed, but could still arrive. The second is from a filament eruption on 12 Apr, also likely arriving early day 1 (15 Apr). This has high confidence for an arrival to occur, however due to being faint in imagery confidence is low with it's the strength. The third is the CME still under analysis from 14 Apr but may arrive on day 3 (17 Apr). Otherwise slightly elevated winds from CH24/- are expected to ease day 2 (16 Apr) onward. Geomagnetic activity is expected to increase from Quiet to be Unsettled to Active with a chance of G1/Minor to G2/Moderate Storm intervals day 1 (15 Apr) due to the CME arrival. A decline in activity is then expected as the effects of these events wane, but with a chance of further Active to G1 Minor storms if any

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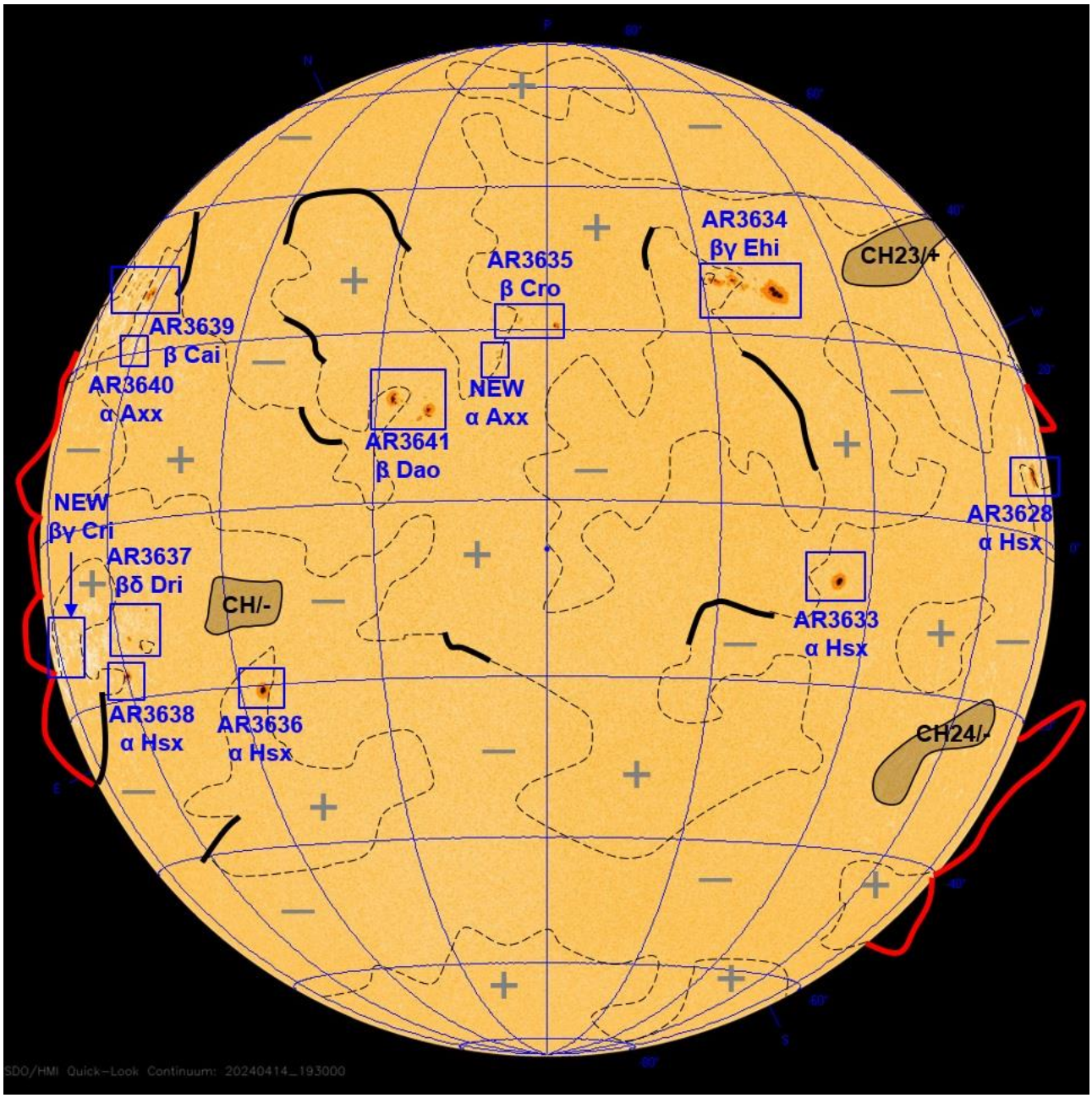
further CME arrival occurs on day 3 (17 Apr).

Energetic Particles / Solar Radiation: High energy proton flux as observed by GOES18 is expected to persist at Background. High energy electron flux at GOES16 is expected ease to background with the onset of any fast wind and CME arrivals, before likely rising later in the period. The associated 24 hour fluence is expected to see a rising trend later in the period, but not expected to reach the Active threshold.

Figure 1. Solar Analysis Valid 14/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are three CMEs of note, with the potential for Earth-directed components.

The first was from a north-centre filament eruption 11/0540UTC, and was expected to pass Earth late on 14 Apr. This has yet to be observed, but was only low confidence for a glance and may yet arrive early on day 1 (15 Apr). The second is from a filament eruption observed just southwest of centre-disc around 12/0020UTC. The subsequent CME is very faint, but perceptible as a full halo on SOHO C2 and STEREO A difference imagery. This is forecast to arrive early day 1 (15 Apr). While confidence is high for this CME to be Earth-directed, it is much lower for the strength of any arrival due to its faint nature.

Arrival of at least one of these CMEs is also supported by ACE EPAM, showing a gradual uptick in the low energy proton flux, which is often observed ahead of CME arrivals.

The third was from a join C5.0 flare and filament eruption of AR3636 in the southeast disc on 14 Apr. Analysis is still ongoing, however this has a potential to be Earth-directed, most likely arriving on day 3 (17 Apr).

The onset of CH24/- fast winds appears to be occurring at time of issue, however any enhancement remains weak. Due to the small size of the feature and lack of evidence in either persistence or enlil, confidence is low for any notable enhancement from this feature. Furthermore the influence of any CME arrivals are likely to dominate for much for the period.

Geomagnetic activity is expected to increase from initially Quiet to be Unsettled to Active with a chance G1 Minor to G2 Moderate Storm intervals on each of day 1 (15 Apr) from the combined fast wind or CME arrivals. Activity likely easing to be predominately Quiet to Unsettled day 2 onward, but with a chance of further increase to Active to G1 Minor Storm from any subsequent CME arrival on day 3 (17 Apr).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	10	30	5
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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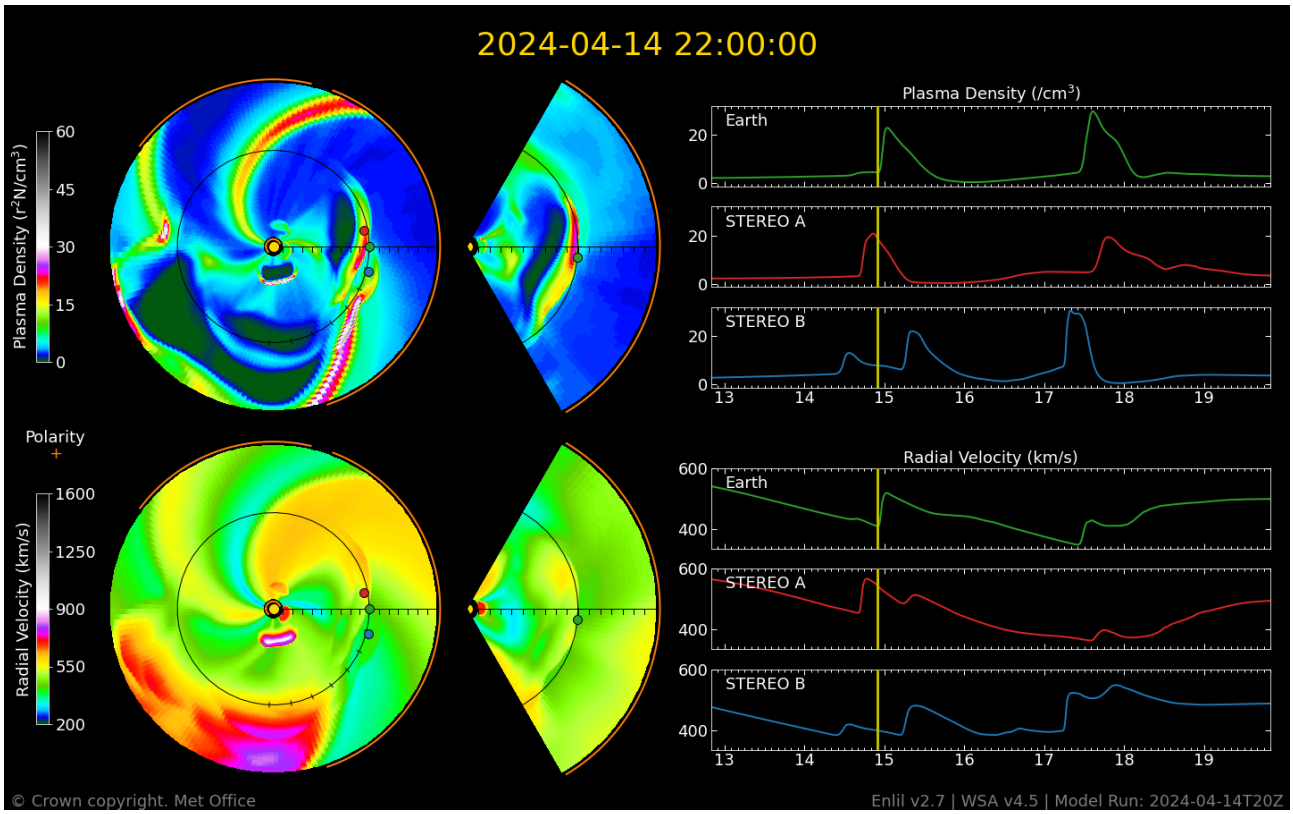
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0620	Full	Filament	N-centre	670 km/s	15/0300 UTC	Direct hit but weak in imagery so strength low confidence
11/0856	Partial	Filament	SE	856 km/s	14/2100 UTC -4/+8 hrs	Glancing impact- likely missed
14/1553	Partial	C5 flare + Filament	SE	680 km/s	17 Apr	Still under review

Figure 2: Enlil showing arrival of CMEs



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Radio Blackouts - X-Ray Flares:

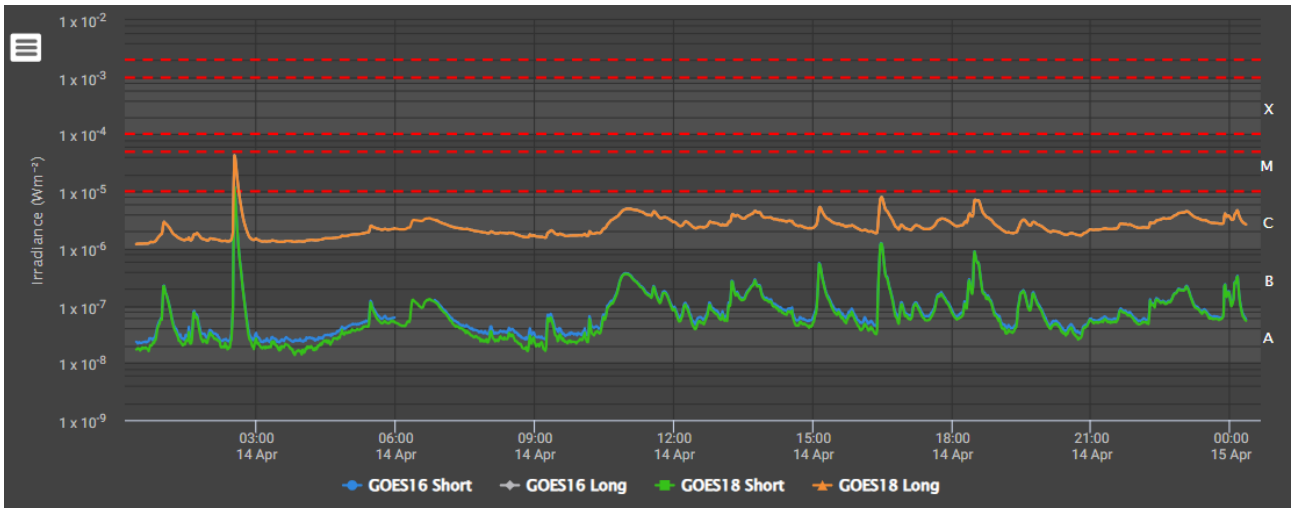
Low to Moderate activity is forecast through the period, with a likelihood of isolated M-class flares. Overall, activity continues on an upward trend with twelve sunspot regions now on the disc.

The most intense of any recent flaring has been from the very small region AR3637 in the southeast, which appears to have a very small delta spot, but no recent growth observed. This is set within a broad area of plage, and further small regions are also rotating onto this limb, associated with bright flux visible on SDO imagery, e.g. aia-94. Similar bright flux is evident in the northeast, associated with AR3639, which has seen recent emergence trailer spots.

The largest region is currently AR3634 in the northwest. This has also seen the development of a small reverse polarity spot to the east of its trailer increasing its complexity. Ongoing growth also continued in AR3641 nearing north-centre with a further new spot emerging to its northwest, near AR3635 in the north-centre disc. There are also a number of other simpler, mature unipolar spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES-16/18 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux as observed by GOES18 has persisted at Background. There is a very slight chance of the observed flux increasing in response to any notable flares, primarily from AR3634 with this region moving towards the western limb through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 is forecast to decline to mainly background as solar wind pressure increases due to the onset of the combined fast wind of CH24/- and potential CME arrivals, compressing the belts inward. Confidence is then low with how much charging the Van Allen belts will receive from these arrivals, but as pressure eases later in the period Moderate, perhaps peaking High flux is possible day 3-4 (17-18 Apr). Although confidence is further reduced by the further potential CME arrival on day 3 (17 Apr).

The associated 24 hr electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold, as supported by REFM, but with an increasing trend most likely by the end of the period. Any CME arrivals will not be captured by current REFM expectations.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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